Ecological Committee on FIFRA Risk Assessment Methods (ECOFRAM)

Terrestrial Workgroup Report: III. Exposure via Ingestion of Granules

Introduction

Of the several ways in which birds and mammals may be exposed to granular pesticides, the ingestion of granules is usually considered to be most important (EPA 1992, Best and Fischer 1992). Granules may be ingested accidentally by animals that obtain food from treated soil or vegetation, or they may be ingested intentionally if they are mistakenly accepted as grit or food.

EPA Office of Pesticide Programs currently uses a hazard index approach ($LD50s/ft^2$) to characterize risk of granular products. The exposure component of this index is an estimate of pesticide load available per an arbitrarily chosen unit area. It is not an estimate of pesticide intake for individual birds, and therefore can not be used in conjunction with the dose-response relationship of acute oral toxicity tests to make predictions about the probability of adverse effects.

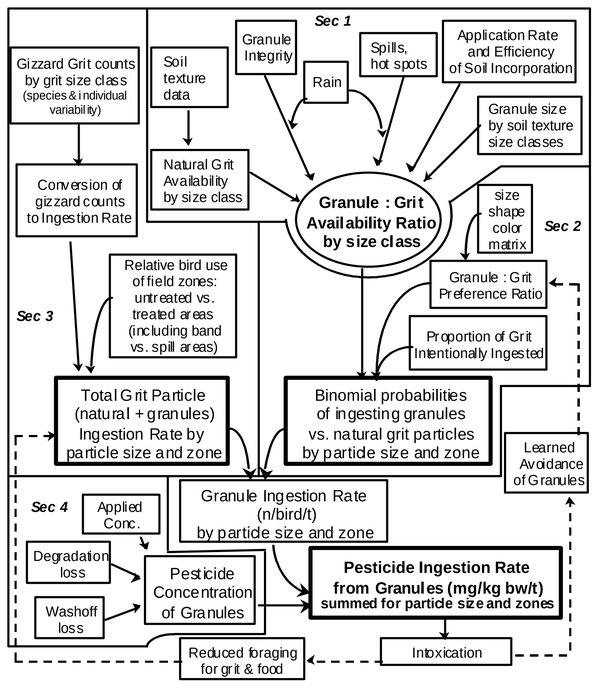
Development of New Tool

A new assessment tool is needed that estimates pesticide intake of birds as a result of ingestion of granules. ECOFRAM reviewed two recent attempts to estimate pesticide intake via ingestion of granules using individual-based, probabilistic (Monte Carlo) models (Abt Associates, 1996; Dixon et al. 1997). A Monte Carlo model is under development that incorporates the best features of these models as well as some new ideas.

As a first step, a conceptual model of factors that potentially influence avian ingestion of pesticide granules was developed (Fig 1). The conceptual model has several modular components:

- Sec 1 estimates the relative availability of granules and natural grit particles of same size
- Sec 2 estimates the probability that a grit particle selected at random by a bird will be a granule
- Sec 3 estimates the amount of grit by size and spatial location a bird ingests
- Sec 4 estimates the pesticide concentration of granules
- Above sections lead to output of pesticide dose ingested
- Sublethal exposure may potentially reduce grit intake and cause avoidance (feedback loops)

Fig 1. Conceptual Model of Bird Exposure via Ingestion of Granules



Levels of Refinement in Analysis of Exposure via Granule Ingestion

	Level 1	Level 2	Level 3
PURPOSE	• Produce conservative point estimate of exposure level • Rapid computation without stochastic modeling	• Distribution of potential exposure under conservative scenario	• Distribution of exposure under more realistic scenarios • Full range of variation in conditions evaluated

Scenario inputs

Parameter	Influencing factors	Level 1	Level 2	Level 3
Availability of Natural Grit Particles (AvlGrt)	Soil texture data (% mass by particle size and mineral type)	Use reasonable worst-case soil (minimal %sand) for crop type	Run model for all major soil texture categories for crop type	Randomly choose soil texture data from NRCS soils "pedon" data base
Availability of Granules (AvlGnl)	Application rate	Maximum labeled rate	Vary rate ± 10% of maximum	Distribution of rates based on actual use data
	% left on surface	95%tile value from applicable data in literature	Full distribution from studies of similar prod-ucts and use patterns	Conduct field measure-ments for the specific product and use pattern
	N & size of hot spots	Assume 4 in^2 spill at end of each row (worst case, expert guess)	Use field data (collect if necessary)	
	Rainfall	No rain	Use conservative estimate of probability of rain each day	Sample rainfall data from random year for appropriate location
	Granule integrity	Granules remain intact	Determine how rainfall affects integrity, define granule loss factor	

Biology inputs

Parameter	Influencing factors	Level 1	Level 2	Level 3
Probability of Ingesting a Granule (ProbGnl)	Granule:Grit Preference ratio	Assume no preference	Use mean estimates of results from lab studies	Use full distribution of results from lab studies
Particle Ingestion Rate (PIR)	Species chosen for modeling	Worst-case species (house sparrow)	Evaluate multiple focal species	
	Amount and size of gizzard grit particles	Mean % use of each size class, 95%tile value for gizzard grit	Sample from actual measurements (eg., Best and Gionfriddo 1991)	
	Turnover rate for gizzard grit particles	Use point estimate (e.g. 4.2X per day based on Fischer and Best 1995)	Use full distribution of lab measurements	
	Use of treatment site and field zones (treated band, untreated area, hot spots)	100% of activity on site; Assume exagerated use of hot spots, otherwise proportional use	Reasonable but conservative distributions of site use and hot spots	Distribution based on field measurements

Chemical inputs

Parameter	Influencing factors	Level 1	Level 2	Level 3
Pesticide Load per Granule	Initial AI Concentration	Nominal formulation %	Field measurement average	Distribution field measurements
	Degradation rate of AI	Assume no degradation	Conservative estimate of rate (pt estimate or distribution)	Field measurement of rate (pt estimate or distribution)
	Washoff rate for AI	Assume no washoff	Conservative estimate of rate (pt estimate or distribution)	Field measurement of rate (pt estimate or distribution)

Analysis outputs

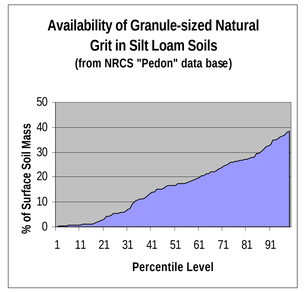
Parameter	Influencing factors	Level 1	Level 2	Level 3
Granule Ingestion Rate (GIR)	ProbGnl, PIR	95%tile value from binomial distribution defined by PIR (n) and ProbGnl (p)	Distribution of values drawn by Monte Carlo sampling from binomial distribution defined by PIR (n) and ProbGnl (p)	
Pesticide Ingestion Rate	All inputs	Conservative point estimate	Distribution of values for conservative scenario	Distribution of exposure values for multiple, more realistic scenarios

How does the model work?

The user specifies the granular product (e.g. granular fonofos), crop (e.g. corn), geographic region (e.g. Midwest), focal species (e.g. horned lark) and number of model iterations to be run. In each iteration, the grit ingestion behavior of an individual bird at a crop field with a randomly selected soil type within the region is simulated. The number and size distribution of particles an individual bird is "programmed" to ingest each day is determined by sampling from the avian grit use data base of Best and Gionfriddo (1991). Every instance in which a bird ingests a particle is assumed to be a binomial trial in which the particle ingested could be a granule or a natural grit particle depending on their relative abundance and the bird's preference for one or the other. Granule ingestion is estimated by sampling from a binomial distribution defined by the particle ingestion rate (N) and probability of ingesting a granule (p). The daily dose of pesticide ingested (mg/kg BW) is determined from the number of granules ingested and the pesticide load.

Model Parameter	Definition	How calculated?
$AvlGnl_{sz}$	Availability of granules of size *s* in zone *z*	From appl. rate, %surface granules remaining, granule size distribution
$AvlGrt_{sz}$	Availability of natural grit of size *s* in zone *z*	From soil texture data (%soil mass and mean particle diameter)
$ProbGnl_{sz}$	Probability of ingesting a granule when a particle is ingested of size *s* in zone *z*	From relative availability of granules and natural grit particles and granule:grit preference factor
$ProbGrt_{sz}$	Probability of ingesting a natural grit particle when a particle is ingested of size *s* in zone *z*	1 - $ProbGnl_{sz}$
GGP	Granule to Grit Preference ratio	Estimated from literature
PIR_{sz}	Particle Ingestion Rate for particles of size *s* in zone *z*	From studies of gizzard grit number, size and turnover rate, and relative size and bird use of field zones
GIR_{sz}	Granule Ingestion Rate for size *s* in zone *z*	Random outcome drawn from a binomial probability distribution based on PIR_{sz} (n trials) and $ProbGnl_{sz}$ (p)
PIRG	Pesticide Ingestion Rate from Granules	$\sum GIR_{sz} \bullet GnlWt_{mg} \bullet \%AI / BW_{kg}$, summed for all particle sizes and zones

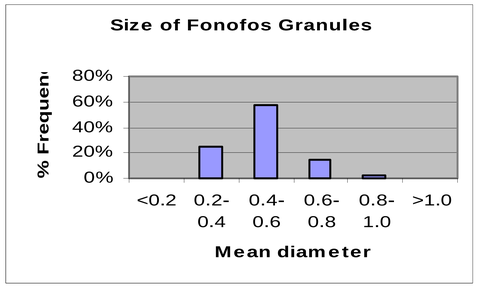
Examples of Inputs and Outputs

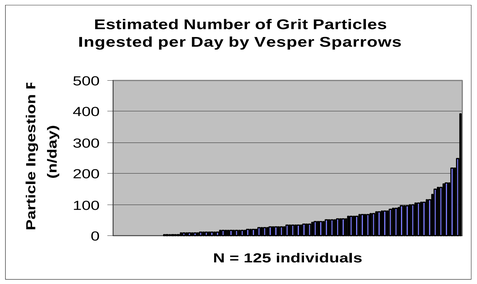


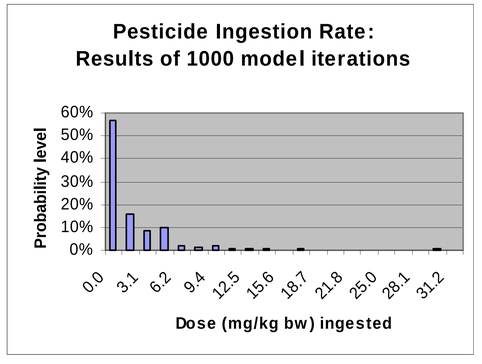
Texture Distributions for Corn Soils in the Corn Belt Region (MO, IA, IL, IN, OH)

Texture	texture index	Acres	percent of area
SIL	1	74,914,189	57.08%
SICL	2	27,542,400	20.99%
L	3	15,703,240	11.96%
CL	4	4,264,848	3.25%
FSL	5	1,944,043	1.48%
SIC	6	1,771,886	1.35%
CLAY	7	1,322,881	1.01%
LFS	8	1,128,911	0.86%
SL	9	1,099,155	0.84%
LS	10	990,900	0.75%
FS	11	317,025	0.24%
S	12	125,238	0.10%
SCL	13	56,305	0.04%
VFSL	14	32,739	0.02%
LCOS	15	16,870	0.01%
COSL	16	15,559	0.01%
(total acres)		131,246,191	

source: STATSGO database, surface texture







Literature Cited

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Abt (Abt Associates Inc.). 1996. Regulatory "cluster analysis" of field corn pesticides. Vols I & II. Report to EPA Office of Policy Analysis. EPA contract nos. 68-W1-0009, 68-D0-0020, 68-W4-0029

Dixon, K., S. Anderson, and M. Hooper. 1997. An individual-based model of chlorpyrifos ingestion and mortality in avian species. Poster PWP058, SETAC Annual Meeting, San Francisco.

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